MINISTRY OF FINANCE, EGYPT.

PETROLEUM RESEARCH. Bulletin No. 6.

PRELIMINARY GEOLOGICAL REPORT

ON THE

ABU SHAAR EL QIBLI

(BLACK HILL) DISTRICT.

By

T. G. MADGWICK, A.Inst.M.M., A.R.S.M.;
F. W. MOON, B.E., A.M.I.C.E., M.Inst.P.T., &c.;
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CONTENTS.

PLATES AND MAPS.

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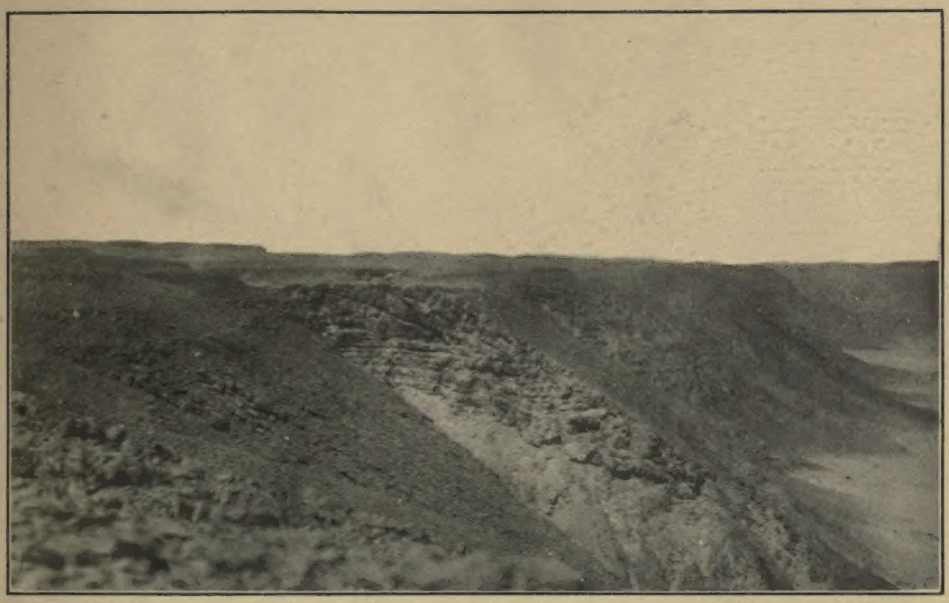
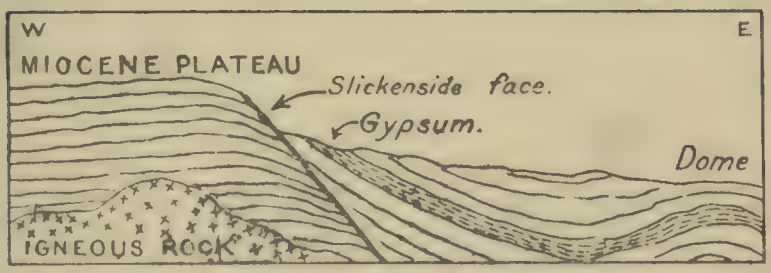


Fig. 1. Photo by W.F. Hume

Monoclinal folding of Miocene coral reef at eastern edge of Abu Shaar Plateau (South).

Fig. 2. Photo by H. Sadek

Monoclinal fold at Bir Abu Shaar; cliff formed of limestone dipping 33° eastward, with gypsum forming low white foothills to extreme right.



Diagrammatic Sketch explaining Monoclinal folding round eastern and southern faces of Abu Shaar Plateau (See Photo Figs. 1 & 2 Plate I).

PRELIMINARY GEOLOGICAL REPORT

ON ABU SHAAR EL QIBLI DISTRICT.

INTRODUCTION.

This report contains the results of the investigation by the Petroleum Research Expedition in the Abu Shaar area. The topographical maps were made by Mr. H. A. Huggins, while the geological details were added by Messrs. T. G. Madgwick, F. W. Moon, and H. Sadek. Mr. R. H. Greaves and Dr. W. F. Hume visited the area towards the end of the expedition.

Notes on Topography.

The area mapped comprises about 200 square kilometres of the northern portion of that part of the coastal plain which lies between the Red Sea hills and the Red Sea, and extends southwards from the Abu Shaar plateau towards Safaga. Farther northwards this plain is split into two strips by the Esh-Mellaha range. The northern limit of the sheet is Bir Abu Shaar, situated under the Abu Shaar scarp (the southern extension of the Esh-Mellaha range), and it extends to the north-western boundary of the Anglo-Egyptian Company's licence at Hurghada, the oilfield of which lies about ten kilometres to the south-east. It is bounded on the east by the Red Sea, and on the west by the Abu Shaar el Qibli plateau, some 200 metres in height. The whole area up to the steeply rising sides to south and east of the Abu Shaar el Qibli plateau is composed of the plain, which rises steadily westwards from the sea. The undulating relief of this sloping plain is dwarfed by comparison with the boldly dissected scarp of the plateau with its precipitous wadis, although in it heights of over 100 metres are obtained.

Westwards the Abu Shaar el Qibli plateau dies down into the plain at an elevation of some 140 metres above the sea level, and this junction was taken as the western limit of the area to be mapped.

The plateau runs from Gebel Esh in a south-eastern direction, and after passing Bir Abu Shaar there is a swing to the south-west, at a point about three kilometres from the Bir and five kilometres from the sea, from whence it gradually falls westwards until it merges into the plain, the latter steadily rising in a parallel direction. The top of the plateau on the northern portion stands at 200 metres above the plain, and it is deeply cut up with wadis, the sides of which are so steep that it is only with great difficulty that its eastern margin can be traversed. The scarp of the plateau is also very steep, only permitting ascent in a few places, whereas the exits of all the wadis, with one exception, are inaccessible owing to the precipitous "sidds," or dry waterfalls. At the south-eastern portion of the area there is an isolated short ridge about 1,500 metres long (with heights of 50 metres), the axis of which runs west of north and shows a steep scarp on the western side. Between this and the coast lies another ridge about 2,000 metres long (with heights of 33 metres), but more broken, and its axis is north-eastwards.

In the south-western portion of the area the plain has risen to 140 metres above sea-level and is characterized by wide, flat undulations tending to the formation of dome-like hills, from which broken ridges descend towards the plain in a north-easterly direction, and parallel with the southern edge of the plateau. These ridges merge into the plain near a line forming the continuation of the main scarp of the plateau. The most definitely marked of these is the one immediately south of the plateau and which forms the right bank of a portion of the Wadi Um Deheis. The end of this ridge curves round in a somewhat disjointed circular form, producing a dome-like structure. This area was mapped in greater detail on the 1 : 10,000 scale.

At the north-eastern part of the area there is a disconnected ridge about 1,500 metres in length (with heights of 17 metres) and one kilometre from the sea ; its axis is a little west of north and shows a scarp on the western side.

Drainage.

The wide sandy watercourses, arising among the easily eroded unconsolidated sediments covering the lower region are short and unimportant, their shortness debarring them from anything but very rare flows of water. The main drainage channel involved in the area is the Wadi Um Deheis, which rises towards the Red Sea hills to the south-west, and flows along the foot of the Abu Shaar el Qibli plateau in a north-easterly direction, only departing from it where the scarp swings round to the north-west. The wadi, crossing the

plain in continuation of its previous course, enters the sea in a small shallow bay, on the southern side of which the ruins of an old Roman fort may be seen on the beach. This bay was formerly the harbour of Myos Hormos, and is still recognized as a port by the Arabs. The approach to the port is at times marshy, and then not a good road for camels.

The Um Deheis receives numerous small tributaries from the gravel area, and an important branch, known as the Kharaza, joins it from the plateau. This traverses the latter and leads up to a small waterhole frequented by herds of sheep.

A wadi cuts through the plateau from the north near the Bir, where there is a well of brackish water; it turns abruptly to the left, and its "seil" or track crosses the plain in a north-eastward direction, entering the sea to the north of that of the Wadi Um Deheis.

To the south, the small wadis that rise in the west and south of the area coalesce to a "seil" which runs north-east across the plain, entering the sea about six kilometres south of the old fort. This "seil" is conspicuously marked by several square kilometres of low thick scrub.

General Notes.

With the exception of the brackish water at Bir Abu Shaar, there is no regular water-supply within the area mapped, although at the time of the survey a flock of goats was being watered at a "galt," or waterhole, up the Wadi el Kharaza, and it was stated by Arabs that this water is brackish but potable. At a point 1½ to 2 kilometres inland from the fort are the remains of a hut and apparently a caved-in well, by the side of which a piece of Roman tile pipe was found.

Beyond the area of scrub referred to, there is no vegetation other than a few stunted trees in the Um Deheis and in the other wadis which dissect the plateau, the two groups of palms at Bir Abu Shaar, some patches of "gharqad" bushes near the shore, and the usual desert grasses and plants in the wadis.

Landing is in general difficult owing to the coral reefs along the sea shore, these extending for several hundred metres seawards, but there is an excellent landing place three kilometres east of Black Hill, where 1,500-ton steamers can approach the shore through a deep-water passage in the outer reefs. High winds from the north-west and north are prevalent and seriously hamper instrument work.

The main map has been drawn on a scale of 1 : 25,000, showing contours of 5-metre intervals. That giving greater detail of the north-east end of the lower Um Deheis dome is on a scale of 1 : 10,000 with similar contour intervals.

Geology.

(*a*) Stratigraphy.

From the younger beds downwards the succession is :—

(1) Alluvium and sands.
(2) Raised coral reef.
(3) *Pecten Vasseli* beds.
(4) Gravels, grits, limestones and cast beds.
(5) Gypsum.
(6) Dolomitic limestone.
(7) Older coral reef, etc.
(8) Igneous rocks.

No determination of the thickness of the various formations is possible; briefly, they may be described as follows :—

1. *Alluvium and Sands.*—The gravels are mainly composed of igneous rock fragments, with much limestone and other material. They are largely derived *in situ* from erosion of outcrops of the older gravels (4), and occupy a large part of the eastern portion of the plain. Finer material fills the bed of the Um Deheis and covers large areas developing from the gravels and draining towards the sea. Finally, near sea-level are flat patches of gypseous and salty silts, covered in one considerable area by scrub.

2. *Raised Coral Reef.*—The coral reef follows the shore line, towards which it has a very gentle dip. It contains, besides corals, coarse sands with numerous shells of recent type. Its thickness is small and it does not extend far inland.

3. *Pecten Vasseli Beds.*—These beds occur only in the south, where they seem to lie unconformably upon the older gravels (4), and represent a receding shore line in Pleistocene or Pliocene times. They contain strata of sands nearly horizontal, and characterized by a well-developed bed of *Pecten Vasseli* overlying a cast bed, and having beneath one containing *Ostrea Virleti*. The thickness exposed is inconsiderable, being merely a thin veneer.

4. *Gravels, Grits, Limestones and Cast Beds.*—The next formation is poor in fossils, those which occur being in rare patches of poorly preserved casts and throwing little light on the age. Gravels form the

upper, grits the lower strata, the former being prominent in the west, where, with interbedded shales, they attain perhaps 200 metres in thickness. Like the grits, they are lenticular and subject to lateral variation, the effect of which on the thickness towards the sea is difficult to estimate, but the general tendency is for the grits to predominate as we approach seawards. South of "Black Hill," the *Pecten Vasseli* beds are either very unconformable or no great thickness of this formation is present. The limestones are a lateral variation of the grits, and tend to appear only near the sea.

The gravels tend in general to form low ridges, along the foot of which it is often possible to follow chalcedonic or shale beds for considerable distances. In this manner it was possible to arrive at an idea of the structure of these beds and hence an approximate estimate of their thickness.

The grits at times are coarse and very massive, and to this is due their preservation in the hills known as "Black Hill" and "Hill 50." At the base of the grits is a green shale of little thickness, but with much salt, often in pure layers, the search for which on the part of the Bedouin has left traces which enable it to be easily followed.

5. *Gypsum.*—Exposures of gypsum occur along the foot of the slopes of the plateau beginning near Bir Abu Shaar, where it appears in some thickness beneath gravels and dipping seawards from the Dolomitic Limestone (6), upon which it appears to lie. The same applies to the next exposure southwards, where the grits become apparent as the overlying formation; farther southwards the dolomite is lost, and only small patches of gypsum of less regular character lie along the left bank of the Um Deheis. These are followed westward by a group of circular patches on the right bank, just south of the point where the plateau merges into the plain. The latter clearly underlies the gravels, etc., but its relationship to the older coral reef will not be clear until some excavation has first been done. The three "domes" of which this group consists probably form the top of a considerable spur of gypsum running southwards from the point where the plateau dies down to the level of the plain.

A more important group of domes lies to the south-east in the Black Hill region, and may also be looked upon as forming one whole. In most parts the conformability of the overlying strata is apparent, and in the case of the main exposure the thickness of the gypsum displayed is considerable. There appears little ground for supposing that the eastern and western areas are not continuous or that they represent deposits of different ages. The facts all point to this area having formed a bay to the main lagoon in which the gypsum series was deposited, and it is unlikely that we have more than a gradually thickening formation as the sea is approached. How deep

the older rocks lie is unknown, but quite possibly in places they may be found at less depths than calculated by comparison with more easterly areas.

6 and 7. *Dolomitic Limestone and Older Coral Reef.*—The dolomitic limestone is a band of limestone without fossils, which was mapped near Bir Abu Shaar, where it forms a band along the foot of the scarp and overlies the older coral reef without apparent unconformity. Being involved in the sharp bend of the monocline, some faulting parallel to the bedding planes has obscured the relations of the two. The coral reef is well developed on the top of the plateau as well, where its relations to the dolomite have not been studied ; it is fossiliferous, but the age has not been determined. Between ten and twenty metres of the coral reef are exposed, the dolomite having a thickness of a few metres only.

8. *Igneous.*—Igneous rocks are seen in the bed of a steep-sided wadi in the plateau. The exposure is small and rather difficult of access.

Unconformabilities.—As already indicated, a considerable unconformability exists between the *Pecten Vasseli* beds and the underlying formation, but this only affects the southern margin of the area. It agrees with the relations noted farther south between the Plio-Miocene and Plio-Pleistocene series. Similarly, a great unconformity is known to exist between the Miocene and the older formations, and is general throughout the oilfield regions, so that it may be expected to cause complications here.

Lateral Variation.—This is of great importance at Abu Shaar, and must be considered in two connections ; first as regards the relation of the western gypsum " domes " to the older coral reef, in which case we have either a thin veneer of gypsum overlying the coral reef, or the one is, in part at least, a lateral variation of the other. Coral reefs are shore deposits, and may have formed a fringe in the early stages of the lagoon desiccation, which resulted in the deposition of gypsum simultaneously or in immediate succession alongside. The latter seems the more likely, and the thickening of the gypsum series towards the east would be dependent on the slope of the lagoon floor, modified perhaps by subsidence. Bearing in mind these considerations, we can scarcely expect much thickness of gypsum in this western area. The problem, however, is not necessarily so simple.

The second case of lateral variation is that the gravel beds characteristic of the western area change to gritty sands and shell limestone in passing eastwards, and along the sea-shore, in the small

exposure in the south-east, clays become prominent. This lateral change is one accompanied by much variation of thickness, the thick beds of gravel being represented by a much thinner facies of grits, etc., towards the sea, and thus having the reverse effect to the lenticularity of the underlying gypsum series as regards the total amount of Upper Miocene-Pliocene strata there likely to be encountered.

(*b*) Structure.

The plunging southward of the Esh-Mellaha range is associated with disturbances in the younger formations occupying the plain. The highly complex structure of the old igneous-metamorphic massif first disappears beneath the Miocene limestone of the Abu Shaar plateau, which is bent along the eastern margin into the monoclinal fold typical of the whole range. Sundry small inliers of igneous rocks, one of which falls within the north-west corner of the map, bear witness to the gradual plunging of the older rocks beneath the plateau, but immediately to the south the plateau itself is terminated by a swinging round to the south-west and disappearance of the monocline, the plateau thus forming the left bank of the Um Deheis.

A notable and continuous feature of the structure along the whole eastern face of the plateau, and part of the area gradually curving round to its southern scarp, is a well-developed slickensided plane, with a dip of 33° (gradually changing from east to south), formed within the steeply-dipping limestone fringe. The best explanation appears to be that the granitic core and part of the limestones overlying it have been slowly uplifted, bringing the upper limestones into a condition of stress, finally resulting to the south in their complete fracture and fault-separation. (*See* Plate 1, figs. 1 and 2, and sketch).

In the broad undulating plain which forms the greater part of the area south and south-east of the plateau rise a series of small geological domes, the principal ones being seven in number. Four of them belong to the coast zone, *viz.* :—

(1) " Orchard " dome.

(2) Black Hill dome.

(3) Hill 50 dome.

(4) South-eastern dome.

Two are just south of the Um Deheis drainage, these being:—

(5) Upper Um Deheis dome.

(6) Lower Um Deheis dome.

There is also a less conspicuous dome to the east of the Upper Um Deheis one. To characterize it, it may be termed :—

(7) Gravel Ridge dome.

The use of the word "dome" does not imply any assumption as to their tectonic origin, whether due to concealed features of more marked disturbances, or to stresses in the gypsum either from compression or hydration of anhydrite, etc.

We will now consider each in more detail.

1. *"Orchard" Dome.*—In the absence of any topographical feature, the name given to it is derived from the "orchard-like" aspect of the scrub area shown on the original map. The dome itself is incomplete, only the eastern flank being exposed from underneath the gravels. The highest dip noted was 20° north-east, otherwise most of the easterly dips do not exceed 10°. The axis of the fold runs approximately north-west to south-east through or near the point marking horizontality on the map. This fold is probably independent of the Lower Um Deheis one lying to the west, but the western flank is entirely hidden by the gravel terraces. The lowest beds in the ridge are calcareous grits, with a bivalve cast band, followed by gravels, in which one bed contained *Ostrea cucullata.*

2. *Hill 50 Dome.*—This is a bigger and more defined dome than No. 1. It is composed of two minor domes, which merge together to form one complete elongated dome, with the axis running more or less north and south. The dips on both flanks do not exceed 10°. In both the minor crests gypsum is exposed, and is overlain on either side by a series of grits and marls in which fossil bands occur. Amongst the bivalves, which are mostly badly preserved casts, is one which is possibly a *Tellina lacunosa.* On this point, however, further search through the fossiliferous horizons is needed before the age of the series could be made out. If this is found to be the *Tellina lacunosa* horizon, then the gypsum exposed at the core of the dome is of the same age as that coming to the surface in the centre of the Hurghada dome, which, if proved, may be of great importance.

3. *Black Hill Dome.*—This is smaller than No. 2, and separated from it by a narrow syncline. Its axis is trending NNE.-SSW. The western flank is very well defined, with dips varying from 10° to 13° in the main. The eastern flank only shows low dips (3° to 4°), and is largely hidden under the alluvium. Gypsum is slightly exposed in the low ground east of Black Hill, overlain by green salty shales and calcareous grits with bands of marls.

4. *South-Eastern Dome.*—This may be a continuation of Black Hill dome to the southward, but with a slightly synclinal folding separating the two. The dips observed do not exceed 5° on the east, only one dip of 10° was observed on the western flank. Only grits and marls are exposed at the surface. The group of domes Nos. 2, 3 and 4, might possibly be regarded as parts of minor crests of a single fold.

5. *Upper Um Deheis Dome.*—The centre of this dome is a small exposure of gypsum, completely enclosed by a fossiliferous calcareous marl. This may be regarded as the main core of the dome. The beds beyond this limited area, such as the grit and clay bands shown on the map, do not completely close round, but swing outwards and may be continued or parallel to similar beds forming the outer circumference of the Lower Um Deheis dome. Similarly, they diverge to the west, and their further course is obscured under the gravel ridges. If the three gypsum exposures represent parts of the same outcrop, the axis may be looked upon as being roughly west-north-west to east-south-east. The character of the western side has not been studied in detail. The dome appears to be open to the west.

6. *Lower Um Deheis Dome.*—Owing to the importance attached to this dome as a definitely closed structure, it was mapped in detail. The centre is a closed ellipsoidal area, in which no gypsum is exposed. Speaking generally, the eastern appears to be the steeper flank, dips up to 27° and 30° eastward having been observed. To the west the dips in general do not exceed 15°, only one near the crest being 20°. The beds noted were mostly grits, shales, and reddish impure limestones. The trend of the axis is slightly curved, but, beginning as a north-south line, bends gently to north-west to south-east in the south. The closed area is a kilometre and a half in length.

It is a question whether the gypsum displayed in No. 5 dome, and probably near the surface in No. 6, corresponds with that farther to the east, as the few fossils obtained in these former areas above the gypsum have a much younger aspect than those found in an apparently similar position (that is, immediately above the gypsum) in the eastern domes.

7. *Gravel Ridge Dome.*—The curve shown on the map is a gravel ridge, the dip slopes of which are believed to represent the dips of underlying beds. If this be correct, then we have another domal area in this locality. This will be one in which systematic pit digging would yield useful information.

The surface results point to the area between the plateau and the sea being one in which the upper strata are of a relatively gentle undulating character.

Oil Prospects.

The oil prospects here are very similar to those existing at Hurghada before drilling operations were thought of. There the indications were a domal structure, a gypsum core, a fetid limestone and sulphur. Here both the first-named features are present, but there is no well-marked exposure of fetid limestone or sulphur indications. On the other hand, there is the very important incentive that oil has actually been proved to exist at Hurghada in strata which we have every reason to believe are existent underground at Abu Shaar el Qibli, so that it only remains for the drill to tell us to what extent our hopes are to be realized.

It appears from our detailed survey of this place that the geological level of the surface in the eastern group of domes represents beds slightly younger than those exposed at the surface at Hurghada, and that the geological levels exposed in the Upper and Lower Deheis domes are even younger still. The differences in level might not amount to more than 30 metres in the former and, say, 70 metres in the latter, which means that if drilling is undertaken it might be expected to strike the oil strata at slightly lower depths, supposing there were no lateral variation.

Oil occurs at Hurghada in two horizons; the one, it is believed, associated with the conglomerate below the gypsum; the other in the Cretaceous shales and sands, some 70 metres to 100 metres below the conglomerate.

In regard to the deeper oil, it is difficult to give a figure owing to unconformabilities. From our present knowledge of the surface and underground geology to north and south of the coastal domes near Abu Shaar, we should expect a boring to traverse :—

1.—Gypsum with clay and limestone bands above, and more massive gypsum below. There might be possible shows of oil in this series at about the 1,000-feet (300 metres) level. But there is a distinct possibility of less thickness.

2.—Globigerina marls or equivalent limestones, with a conglomerate at the base, in connection with which there might be an oil-horizon.

3.—Fine sands, limestones and shales of Cretaceous age to an unknown depth, followed by typical Nubian sandstone.

Only boring can show whether this succession will also hold good for the domes nearer the plateau, or whether there is a salt area underlying the plain, or unknown factors introduced by proximity to the fault disturbances determining the plateau and the ancient shorelines associated with the latter.

It must not be forgotten that the domes hitherto tested are of two kinds, one in which gypsum is present without evidence of salt, while in others salt is present in great quantity with the gypsum. Hitherto no evidence of oil in payable quantity has been found in borings with marked salt-beds, and should such be entered during boring operations it will be advisable to consider whether the boring should be abandoned and another undertaken elsewhere, or whether a very deep boring should be sunk in order to prove once and for all whether deeper oils are present under the salt strata.

Much light could be thrown on the tectonics of the Abu Shaar area by shallow drilling in various places and by pits or costeans, but deep drilling is necessary to test the presence of oil.

Conclusion and Recommendations.

From what has been said above about the presence of geological domes in this area with the oil series of Hurghada still under ground, we are driven to the conclusion that there is much to recommend a diligent search for oil. It is therefore suggested to make a location for a test well at or near the crest of one of the domes referred to in the report, and the most likely spot seems to be at the crest of the dome Hill 50, as shown on the map. Here the well should be prepared to go down, if necessary, to a depth of at least 3,000 feet.

In addition, a lighter rig might be employed to test the character of the gypsum covering, a definite spot in the middle of the gypsum area north of Hill 50 (as shown on the map) being recommended.

With regard to the surface development, much could be done by shallow pitting undertaken in order to trace definite beds below the alluvium and thus to obtain a complete view of the structure of the whole area.

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PLATE I

33° 45′